On the Meaning of Economic Efficiency in Policy Analysis

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ABSTRACT. *There are crucial differences in the normative foundations of alternative economic criteria used to assess the "efficiency" of policy proposals. Differences between Pareto and potential Pareto measures are emphasized in this comparison of "efficiency" standards. Technical distinctions between these two criteria are examined and illustrated. It is argued that potential Pareto criteria have greater disciplinary acceptance than their normative foundations merit and, further, that the Pareto measure has suffered undue criticism from association with its potential Pareto namesake.* (JEL A11)

I. ON THE MEANING OF ECONOMIC EFFICIENCY IN POLICY ANALYSIS

Along with the increasing relevance of applied welfare (policy) analysis over the past few decades, an important transition in the economist's perception of economic efficiency has been occurring. Pareto optimality (PO)[1] has been progressively ousted as the operational definition of efficiency. Today, PO serves merely as a figurehead with true power usurped by other leading images of economic efficiency. The current state of applied economics finds PO serving in but two roles. Except for the transfer of disciplinary power inherent to both roles, PO has grown analytically passive and irrelevant.

The first role pertains to the mathematical relationship between economic states that are PO and economic states obtained by market institutions. Informally stated, market-obtained economic states are PO under suitably restricted conditions involving atomistic agents, decreasing returns, no externalities, no nonrival goods, etc. Commonly calling it the first theorem of welfare economics (Varian 1992, 326), economists employ this relationship to derive confidence in the desirability of competitive market structures. Although this theorem was presumably conceived to portray competitive markets as legitimate means to an end (PO), it often appears in contemporary discussion that markets have been elevated to an "end" status. After all, the conventional approach to applying a theorem is to first affirm the verity of the theorem's assumptions for the question at hand. Because this is not common practice in most professional promotions of market institutions for confronting emerging policy issues, the first theorem of welfare economics is not being well applied. Even so, the association of competitive equilibria and Pareto optima is being loosely relied upon by applied economists in our clamoring for greater competition, more private property arrangements, and broader market purview.

The second role performed by PO involves its extension to compensation tests. Because PO is not a highly discriminating criterion, owing to its weak normative precepts, more potent criteria were sought by John R. Hicks and his contemporaries. Found were a class of criteria termed potential Pareto criteria or compensation tests. According to these criteria, a policy change is judged to have merit if policy beneficiaries gain more than is forfeited by policy losers. Repeated applications of these criteria to analyze public policy now lead economists in pursuit of potential Pareto optimality (PPO).[2] Although the originators

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[1] "Pareto optimal" and "Pareto optimum" will also be abbreviated as PO. The context will suggest the appropriate term.

[2] In other words, when all potential Pareto improvements have been exhausted in an economy, a PPO has been obtained.

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of PPO criteria struggled with the normative underpinnings of their contributions (without complete satisfaction I will argue), the empirical distractions of complex policy analysis make it easier for modern analysts to overlook limitations. Also, lack of attention to the normative failures of PPO goals is made easier by the association of these tests with the appealing PO norm and the fact that consumer/producer surplus-maximizing models (which are PPO driven) emulate hypothetical market outcomes.

Therefore, we have come to a disciplinary juncture where both market equilibrium and PPO concepts are bolstered by their association with the appealing Pareto norm of efficiency. These royal relatives do not possess the same character as PO, however, and it is the purpose of this paper to examine this point in detail. Because emphasis is upon the implicit efficiency constructs of policy analysis, the investigation will focus upon PPO criteria such as the Hicks (1941) and Kaldor (1939) criteria as they are customarily employed. The primary objective is to contrast potential Pareto and Pareto measures of proposed policies.

II. THE PERVASIVENESS OF PPO CRITERIA

In an era when much of the analytical efforts of applied economists is devoted to policy analysis, PPO criteria have progressively become more important tools. There are at least three distinguishable avenues for incorporating PPO in policy studies. The common feature of these alternatives is that they all aggregate welfare measures across individuals, something the Pareto criterion declines to do.

The most simple of the three involves the aggregation of surplus measures (consumer and/or producer, Marshallian or Hicksian) obtained for affected people/sectors in the case of a proposed, single-period policy. This method supports policy adoption if the summed surpluses are positive. In their printed versions, some empirical studies of this type cautiously stop short of summing the separately reported surpluses, but less careful readers find it to be an easy and seemingly compelling step to perform.

The second form of PPO criteria is similar to the first except that the temporal nature of policy impacts is recognized, and a revised method of aggregation is employed. The classical example of this form is the cost-benefit analysis of a prospective public project. Welfare measures obtained for different individuals or sectors in any one period are additively aggregated as above, but welfare effects occurring in different periods are weighted differently according to the selected discount rate. Again, the policy is judged desirable if the summed welfare measure (net present value) is positive.

The third form is founded upon Samuelson's (1952) observation that a linear programming model maximizing the sum of producer and consumer surpluses will select the same output levels as does the decentralized activity of many profit-minded firm managers. This result was generalized by Takayama and Judge (1964) to pertain to quadratic models as well as the resolution of equilibrium prices. As a consequence of these findings and their extensions, mathematical programming models incorporating supply and demand functions and maximizing total surplus are known to simulate competitive market outcomes. With the inexpensive computing power available today, the incidence of this form of applying PPO criteria has grown (see reviews by McCarl 1992; and Meister, Chen, and Heady 1978). While Samuelson (1952) expressed caution regarding the interpretation of a surplus-maximizing model, practitioners of this method sometimes view their results as a depiction of what resource allocation *should* be. This is a different perspective than viewing results as a depiction of what resource allocation *would* be if competitive markets were prevalent.

These three modes of applying PPO have become commonplace in applied economics. Judging from recent literature, when a course of public action has been labeled more economically efficient or inefficient than another by some analyst(s), the ruling is more often derived from PPO than from PO. This can be disconcerting for a few reasons. Disciplinary purists argue that PO is the only legitimate meaning of efficiency (Lang 1980). More fundamentally, the normative bases of the two criteria are different. For this reason, the "efficiency" label carries different meanings when the measuring rods are different. The knowledgeable audience wishes to know which criterion has been used. The uninformed audience of noneconomists may need to receive additional words of caution when the gauge is PPO.

Another disappointing aspect of the inconsistent use of efficiency terminology is that critics of efficiency criteria seem mainly concerned about the use of PPO norms, not PO ones. Because economic analysts usually fail to indicate whether efficiency is being assessed by PO or PPO criteria, disciplinary criticism regarding efficiency appears to be broadly applicable to both criteria. This is not generally true, however, and it is worthwhile to revisit the relationship of these alternative meanings of economic efficiency so that the various criticisms can be sorted out.

III. THE GENERAL CORRESPONDENCE OF PO AND PPO CRITERIA

The typical policy analyst would like to possess an analytical tool capable of indicating whether any given policy should be adopted. The purist notion of a Bergson social welfare function, $SW = f(U_1, U_2, \ldots, U_K)$, would perform this task, but there are enormous practical problems to be faced in constructing such a tool, and the Arrow Possibility Theorem tells us that such a function would possess technical or normative flaws (Arrow 1963). PO is a useful substitute for a social welfare function, because PO is a necessary condition for maximizing Bergson social welfare (Samuels 1992, 62, 65). Therefore, if an economic state is not PO, then we know that social welfare has not been maximized even though the social welfare function is unavailable to us. For this reason the economist is motivated to pursue PO.

So that the Pareto and potential Pareto criteria may be compared carefully, some formality is useful. It is well known that the PO criterion gives rise to the following optimization problem for an exchange economy of K individuals and N goods:

$$\max_{\underset{\sim}{x}} V^j(x^j) \text{ subject to } \sum_{i=1}^{K} x^i \leq \bar{X} \quad \text{and } V^i(x^i) \geq \bar{V}^i \quad \forall\, i \neq j. \qquad [1]$$

In this Pareto problem, j designates a randomly selected person; x^i and x^j are consumption bundles ($N \times 1$); the V are utility functions dependent upon each individual's consumption; $\underset{\sim}{x}$ is a matrix composed of all consumption bundles ($N \times K$); $\bar{X}$ states the amount of all products available for consumption ($N \times 1$); and the $\bar{V}^i$ are arbitrary, constant utility levels that are varied. There is at least one solution to [1] for each selection of a feasible $\underset{\sim}{\bar{V}} = (\bar{V}^1, \bar{V}^2, \ldots, \bar{V}^{j-1}, \bar{V}^{j+1}, \bar{V}^{j+2}, \ldots, \bar{V}^K)$, and PO pertains to *all* possible $\underset{\sim}{\bar{V}}$. If $\underset{\sim}{\bar{V}}$ is not varied but is instead established at prevailing utility levels, then problem [1] concerns Pareto improvement, and the solution will be a subset of the PO allocations.

The solution to problem [1] can be well illustrated by a utility possibility frontier. This same Pareto problem also describes the production issue giving rise to a production possibilities frontier if production functions are substituted for the value functions and x is a scarce input. A fuller optimization problem incorporating utility functions, production functions, and resource constraints is needed to completely depict the concept of PO when both production and distribution are variable,[3] but the basic formulation of [1] is sufficient grounds for the contrasts to be drawn here.

In exchange, production, or exchange-production settings, the optimizing solutions

[3] Baumol and Oates offer a notationally compact model of PO in a many-consumer and many-producer economy (Baumol and Oates 1988, chap. 4).

to [1] are usually represented by an infinite number of economic states. Moreover, many pairs of economic states are not Pareto comparable. Therein lies the dissatisfaction of the PO norm. It is not, as stated earlier, very discriminating. To obtain a sharper edge, PPO criteria make two crucial modifications to the above problem. First, the structure of the optimization problem is altered to

$$\operatorname*{Max}_{\underline{x}} \sum_{i=1}^{K} V^i(x^i) \text{ subject to } \sum_{i=1}^{K} x^i \leq \overline{X}. \qquad [2]$$

Here, a set of $K - 1$ constraints has been eliminated from problem [1], and the value functions for all K individuals are additively incorporated in the objective function.[4] The second change is that, due to the unobservability of utility, the V^i are represented by monetary measures of utility.[5]

Except for the Samuelson-derived (1952) form of PPO described in the previous section, PPO applications do not perform optimization as indicated by [2]. Instead, the current economic state is contrasted with a proposed state involving the adoption of a particular project or policy. If the proposed state offers greater $\Sigma_{i=1}^{K} V^i(x^i)$, then the proposal is taken to be preferred.[6] Iterative application of such a criterion suggests the optimization problem given by [2], however, and framing potential Pareto criteria in this manner highlights the properties of the ultimate economic states being sought through application of these tests.

In spite of superficial similarities, problems [1] and [2] are quite different. The two modifications to the Pareto problem, additivity and monetarization, are purposeful. They enhance empiricism and greatly reduce the number of optimum economic states. A single economic state will often satisfy [2] whereas problem [1] is solved by an infinite number of economic states. Each of the two modifications has important roles in distancing potential Pareto rules from PO, and it is advantageous to examine them separately.

IV. ADDITIVITY

The additive construction of the objective function in problem [2] is central to a normative investigation of potential Pareto criteria. Quoting the senior architect, "If *A* is made so much better off by the change that he could compensate *B* for his loss, and still have something left over, then the reorganization is an unequivocal improvement" (Hicks 1941, 111). The implication of this argument for applied work is that compensation tests operate by adding monetary measures of utility.[7]

Therefore, the transition from problem [1] to problem [2] involves the transformation of arbitrary constraints into payoffs and penalties. PO espouses impartiality and distributional tolerance by maximizing an arbitrary individual's utility for all possible utility levels for all other people.[8] Consequently, PO envisions many *efficient* states of the economy. PPO, on the other hand, maximizes aggregate welfare without any special attention to preserving individual utility at any level. PPO accepts, even seeks, harms to individuals as long as offsetting positive effects for other individuals can be obtained. By using PPO norms, the

[4] As in the case of problem [1], the exchange economy of [2] can be augmented by production relationships to address a fuller range of issues.

[5] In pure production settings such as that used to derive production possibility frontiers, no surrogate measures are necessary. Production or profit units can be employed.

[6] It is noteworthy that whereas problem [1]'s objective function is the utility function of an arbitrary individual, problem [2]'s objective function, ΣV^i, is a social welfare function, and it must therefore answer to the Possibility Theorem by failing to satisfy one or more of the desirable conditions set forth by Arrow (1963).

[7] To be more precise, Boadway and Bruce (1984, 263–71) show that the sign of summed monetary measures provides a necessary, but not fully sufficient, condition for satisfying any compensation test. This result is more thoroughly examined and extended by Blackorby and Donaldson (1990).

[8] Note that PO should not be confused with the Pareto improvement criterion. Pareto improvement does not employ arbitrary utility levels for all individuals; it uses current utility levels.

economist sets aside the disciplinary vows of distributional sanctity that we so often claim.

From a mathematical perspective, the conversion of constraints into payoffs and penalties produces a subtle alteration in first-order conditions emerging from problems [1] and [2]. The Lagrange approach of affixing the value function constraints to the objective function of problem [1] results in necessary conditions differing from those of [2] mainly in the addition of Lagrange multipliers. As a consequence, the solution of [2] also solves [1], although the converse is not true. This mathematical relationship makes it easier to be deceived into thinking that problem [2] formulations are as normatively acceptable as Pareto optimality problems.

The normative grounds for transforming a maximize-individual-welfare rule into a maximize-aggregate-welfare rule are found in two rationales. One justification is derived from the classical dichotomy of production and distribution. The other is based upon a "law of averages."

According to the first point, the economic issues of efficient production and income distribution are separable (Kaldor 1939). On this basis, it is argued that any social harms brought about by compensation tests can be undone by redistributive policy. Even more strongly, proponents of this perspective sometime maintain that it is the duty of economists to avoid pronouncements concerning distribution. If the production-distribution dichotomy is valid and redistributive policy is sufficiently costless not to be dissuasive, this seems to be an agreeable reason for reshaping the Pareto mission into a compensation test. The assumptive base here is unlikely to be fulfilled, however, and the resulting support for PPO is severely weakened.

Redistributive policy is notoriously costly with well observed net "welfare" (i.e., summed surpluses) losses. Empirical findings on this subject emphasize the losses caused by labor supply responses to changes in tax rates at the margin (Ballard 1988; Browning 1993; Fullerton 1991). The methods and data of this research are varied—leading to a wide range of results, but all the findings indicate sizable losses. Even if one excludes the cost of administering redistributive policy, contemporary empiricism finds that the cost of transferring a dollar can easily exceed yet another dollar. Therefore, just as every policy augmenting the value of total production affects distribution, redistributive programs generally lessen the aggregate value of total production. Because of this, the production-distribution dichotomy is an assailable basis for legitimizing PPO.

The second argument in support of the normative validity of PPO, a sort of "law of averages," has been well advocated by Hicks:

> If the economic activities of a community were organized on the principle of making no alterations in the organization of production which were not improvements in this sense [*PPO*], and making all alterations which were improvements that it could possibly find, then, although we could not say that all the inhabitants of that community would be necessarily better off..., nevertheless there would be a strong probability that almost all of them would be better off after the lapse of a sufficient length of time. (italicized note added) (1941, 111)

Hicks goes on to argue for patience in reaping the social rewards of the PPO norm. He maintains that continued application of a PPO criterion to resolve every policy matter will, over time and on the whole, tend to benefit every person even though each person may be harmed by particular policy selections. Mishan (1980) also observes this point, although it is not clear whether he subscribes to it. To hold this view, one must believe that there are not systematic biases built into PPO criteria which might consistently advance one person's or group's interests against the interests of others. However, consider that the sequence of status quo positions emerging from the adoption of successive policy measures will not be independent. Each of the status quo positions, from which the next policy choice will be made, will be somewhat different, but each is linked to the preceding position thereby creating a systematic preference toward particular interests, especially those people whose wealth gives them weight in surplus measures.

Each of these two arguments does not withstand the test of noncasual inspection, and the normative basis of PPO is seemingly weak. The next section attempts to add some concreteness to this discussion using a numerical example.

V. EXPLORING ADDITIVE MEASURES VS. THE PARETO CRITERION

To focus attention upon the additive objective function of problem [2] and to separate this modification of [1] from the monetarization of utility, consider the following production-only setting. Local public land (L) and water (W) resources are to be allocated between two alternative concerns, mineral (M) and timber (T) production. Available technologies are given by

$$M = aL_M^b W_M^c \text{ and } T = dL_T^e W_T^f$$

where all coefficients are positive, $b + c < 1$, and $e + f < 1$. Available land and water resources are $\bar{L}$ and $\bar{W}$. The simplicity of this example conveys ease of investigation while helping to build intuition concerning the application of PPO norms.

When consulted to examine policy in this matter, many applied economists would tend to examine mineral and timber demand and employ this information to maximize the total value of land and water, following problem [2]. A precisely equivalent procedure would be to maximize the sum of producer and consumer surpluses over feasible allocations of L and W. In the simplest case, that of invariant mineral and timber prices (p_M and p_T) dictated by regional markets, application of the PPO norm requires the maximization of $p_M M + p_T T$. A single allocation of land and water will solve this PPO problem—a fact to be demonstrated shortly.

The simplicity of PPO approaches to such resource allocation issues is achieved by abstracting from the welfare of involved persons. If mineral and timber proceeds are equally shared by members of the local community, then the PPO approach is easily commended. In the absence of this unusual case, the applicability of the PPO approach is clouded. When two people or sets of people have differing interests in mineral and timber rewards, a PPO framework misses the more immediate social issue which emphasizes the distribution of gains.

The PO problem confronts the distributional issue more directly. Either maximizing M subject to arbitrary T production or maximizing $p_M M$ subject to arbitrary T revenue results in the following solution:

$$bf\bar{L}W_M - ce\bar{W}L_M + (ce - bf)L_M W_M = 0. \quad [3]$$

This efficiency locus specifies a relation between water and land allocations that must be maintained for PO. The PPO solution must also satisfy this relation, but its necessary conditions are further resolvable to a single point on this locus. In general, an analytical form for the production possibility frontier or revenue possibility frontier cannot be obtained from [3]. In the special case of $ce = bf$, the production possibility frontier is

$$T = d\left(\frac{\bar{W}}{\bar{L}}\right)^f \left(\bar{L} - a^{\frac{-1}{b+c}}\left(\frac{\bar{W}}{\bar{L}}\right)^{\frac{-c}{b+c}} M^{\frac{1}{b+c}}\right)^{e+f} \quad [4]$$

The impact of the economist's two avenues for participating in this policy issue can now be illustrated for specific parameters: $(a, b, c, d, e, f) = (5, \frac{1}{4}, \frac{1}{2}, 3, \frac{1}{5}, \frac{2}{5})$; $(\bar{L}, \bar{W}) = (80, 10)$; and $(p_M, p_T) = (1, 4)$. For comparative purposes, the results of 500 random allocations of land and water are plotted in Figure 1. Also graphed is the PO frontier given by [4] and the PPO solution occurring at $(M, T) = (17.66, 15)$. It is interesting that every point of the feasible region is not equally likely in the event of totally uninformed (random) input assignments. Few of the random allocations produce output bundles lying far from the frontier.

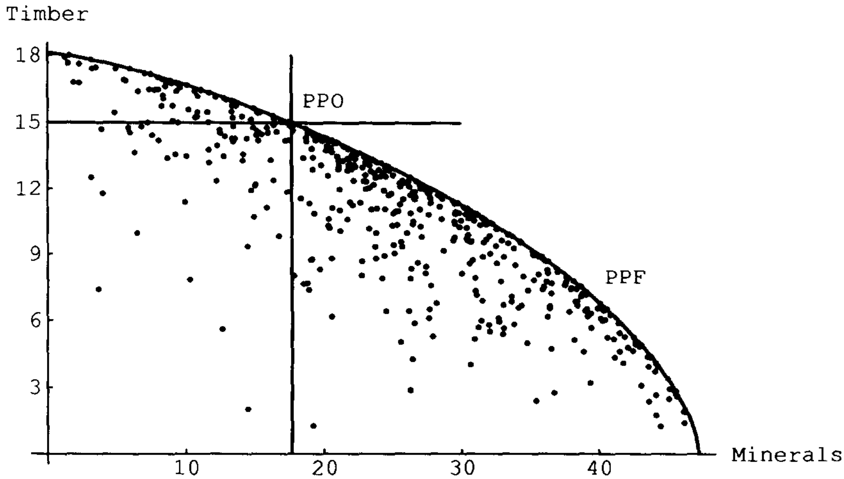

FIGURE 1
ADDITIVITY: PO VERSUS PPO IN A PRODUCTION SETTING

In a similar vein, the single PPO allocation does not provide much more total revenue than do many other PO allocations. At the PPO allocation, mining revenue is \$17.66 and timber revenue is \$60 for a total of \$77.66. A more egalitarian allocation producing $(M,T) = (33, 10.15)$ yields \$33 of revenue for mineral interests and \$40.58 of revenue for timber for a total of \$73.58. The greatly improved equity has been achieved for a \$4.08 loss (5.3 percent) in total value.

In this simplistic example, if the economist recommends the PPO allocation as "efficient," then he/she is also promoting some degree of inequity (\$17.66 for one group and \$60 for the other). If the economist is steadfast in his/her recommendation and invokes the production/distribution dichotomy in defense, arguing that a separate redistributive policy can correct undesirable distributional impacts, then he/she is ignoring the relatively low costs of achieving better distribution without additional, redistributive policy.

If the economist declines to endorse a specific allocation and instead suggests arbitrary partitioning of water and land property, so long as it is transferable, then the economist might be on solid disciplinary ground so long as the assumptions of the first welfare theorem appear to be met. In the latter case, the economist's efficiency recommendation is founded on PO, not PPO, and popular forms of empiricism, such as surplus-maximizing models, do not contribute to the recommendation unless the interpretation is quite cautious. By narrowing attention to a single point of resource allocation, a surplus-maximizing model ignores all PO allocations except one. Therefore, if the economist wishes to invoke the first welfare theorem to recommend a market policy with arbitrary property assignments, then the surplus-maximizing model identifies only an example outcome.

VI. MONETARIZATION

The use of monetary measures of utility also has strong normative implications. Moreover, it is at this point that not one but an array of differing potential Pareto criteria emerge. Although all are additive and are subject to the normative problems discussed previously, the various criteria differ in the bases of their comparisons. Empiricism generally relies upon the Marshallian measure of consumer surplus, and analysts often point out that this measure is numerically bracketed by the theoretically preferred (*exact*) compensating and equivalent variation (CV and EV) measures. The common argument is that Marshallian consumer surplus is acceptable because it approximates CV and EV.

What then are the grounds for using CV or EV as a proxy for a utility change, and how are we to choose between them? The CV measure arises from the Kaldor criterion (Sen 1979, 30-1); it employs a "status quo ante" perspective (Graaff 1957, 86n), and is assessed from an individual's starting utility level.[9] The EV measure is derived from the Hicks criterion which uses a "status quo post" perspective evaluated from an individual's ending position. In this light, the increasingly common professional reference to a "Kaldor-Hicks criterion" is truly strange, because these are two distinct criteria (Boadway and Bruce 1984, 135-7).

Both CV and EV are commonly termed Hicksian measures to acknowledge that they are computable as integrals under Hicksian, rather than Marshallian, demand curves. The facts that CV and EV value functions are different and that they are predicated upon different utility levels imply that the value functions of problem [2] might be better written as $V^i(x^i, U^i)$. The issue of Kaldor versus Hicks criteria is not academic, for the two would be expected to lead to differing solutions for [2]. Nor can comfort always be found in the possible proximity of the Kaldor and Hicks solutions to [2]. As an example, environmental economists have encountered substantial divergences between willingness-to-pay and willingness-to-accept measures of environmental degradation (Knetsch 1990).

The Kaldor criterion finds favor from the implicit licensing inherent to the social actions that brought about the starting positions. This can be perceived as validation, of a sort, for the Kaldor criterion. It can be argued that the economy's position at the starting utility levels sanctions these levels to some degree. On the other hand, although political and other realities suggest attaching some importance to the status quo, other social values may indicate that certain aspects of the status quo have little by which to commend themselves.

It is also apparent that the Kaldor criterion has been firmly embraced by cost-benefit analysts. For example, federal rules require its use for the analysis of U.S. water projects. According to Mishan's text on cost-benefit analysis, "The notion of an economic event, or reorganization, that can make everyone better off requires that we use the CV concept only" (1976, 137). Curiously, this statement is clearly descended from the Pareto criterion. The keyword "potential" is noticeably absent from the quotation, again attesting to the strength of PPO's dependence upon PO and the fluid (and sometimes fallacious) way in which economists move between these two concepts. However, the Pareto criterion is not connected with a particular status quo, and it is incorrect to invoke a Pareto-derived argument to favor a particular compensation test over another.

The Hicks criterion, being applied from the perspective of end-state utility levels, must find its acceptance in the appropriateness of the welfare distribution of the end state. The mere fact that the end state stands as a seriously proposed economic position may offer some justification for this selection. For whatever reasons, someone or some group has a vision that the proposed economic state is a place to which society might wish to move itself. Another source of support for the Hicks criterion lies in the relative ability of CV and EV measures to correctly rank reallocations from one economic state to two alternatives. It has been observed that only EV can be depended upon to perform this ranking correctly, and it is argued that some preference should be granted to the EV metric for this reason (McKenzie and Pearce 1982; Morey 1984). This position indicates an affection for the

[9] Welfare theorists observe that the correspondence between the Kaldor criterion and CV measures is loose because a positive sum of CV's is necessary but not sufficient for a potential Pareto improvement of the Kaldor variety (Blackorby and Donaldson 1990). A similar result undoubtedly relates the Hicks test and ΣEV.

Hicks criterion as opposed to the Kaldor test. On positivist grounds, the argument is correct, but it seems odd to resolve an overwhelmingly normative issue on the basis of a mathematical technicality.

Overall, both Kaldor and Hicks tests have some subscribable normative foundations.[10] They differ in only the utility argument of $V^i(x^i, U^i)$, but this difference is enough to alter decision making. Expanding upon these concerns, why constrain our attention to initial and ending welfare levels? Might not another utility level, one neither initial nor subsequent, be the "Best Utility Basis" for obtaining a monetary measure of utility? It is conceivable that a Best Utility Basis would yield results not well approximated by either Kaldor or Hicks criteria. The presence of U^i in $V^i(x^i, U^i)$ clearly suggests that there is an infinite number of compensation tests, not just two.[11]

It is intriguing that the purview of Hicksian welfare economics has been focused upon two alternatives when the choices are infinitely numerous. It is not difficult to conceive of situations in which other PPO norms could be recommended. For policy proposals that do not appreciably impact the conditions of the impoverished, neither Kaldor nor Hicks measures give much weight to these people. This arguably renders Kaldor and Hicks measures socially unacceptable in particular circumstances; perhaps another Hicksian measure involving neither initial or end-state utility levels would be the Best Utility Basis. This thought is considered in the example developed within the following sections.

VII. EXPLORING THE CONSEQUENCES OF MONETARIZING UTILITY

Suppose that individuals A and B have preferences concerning commodities x and y given by

$$U_A = x_A y_A^d \text{ and } U_B = x_B^f y_B^g$$

where the parameters d, f, and g are positive. Available x and y are $\bar{X}$ and $\bar{Y}$. To render policy analysis more meaningful, we can treat this setting as one *not* dominated by market-determined prices and quantities. Suppose then that government influences either prices or quantities directly. A common form of policy analysis would be captured by comparing a new price vector to an initial price vector to determine whether gainers could hypothetically compensate losers according to one of the compensation tests. Similarly, a common form of project analysis would compare a proposed allocation of commodities to the prevailing allocation to see whether gainers are able to hypothetically compensate losers. Price changes represent an indirect instrument, so let us proceed by dealing with quantities directly. Therefore, this example pertains to project analysis.

Rather than perform a pairwise comparison of selected initial and subsequent allocations of commodities x and y, we can attempt to determine the subsequent allocations that maximize the value functions obtained when utility functions are monetarized. In this case the appropriate monetarizing functions are the Hicksian measures for quantity changes, exemplified by compensating surplus (CS) and equivalent surplus (ES). CS is obtained through application of the Kaldor criterion for quantity changes, and ES is derived from the Hicks criterion. Therefore, CS uses initial utilities as the basis of measurement while ES employs subsequent utilities. In order to entertain the possibility of noninitial and nonsubsequent utility bases, the monetarizing functions developed here will be functions of arbitrary U_A and U_B.

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[10] When employed collaboratively, application of the Kaldor and Hicks criteria is equivalent to applying the Scitovsky double criterion which was proposed as a remedy to the possible circularity of a single test (Boadway and Bruce 1984, 99).

[11] It is not being suggested that the U^i can take on any values whatsoever. A reasonable requirement may be for the K different U^i's to be consistent in that they are mutually supportable by available technologies and resources. That is, it may be necessary to select from points on or within the utility possibility frontier. Still, there are infinite alternatives.

Letting $p_y = 1$ and $p_x = p$, the corresponding expenditure functions are

$$e_A(p, U_A) = \frac{1+d}{d}(dp)^{\frac{1}{1+d}} U_A^{\frac{1}{1+d}} \text{ and}$$

$$e_B(p, U_B) = \frac{f+g}{g}\left(\frac{gp}{f}\right)^{\frac{f}{f+g}} U_B^{\frac{1}{f+g}}.$$

Differentiating these with respect to p to obtain Hicksian demands for x yields

$$h_A(p, U_A) = (dp)^{\frac{-d}{1+d}} U_A^{\frac{1}{1+d}} \text{ and}$$

$$h_B(p, U_B) = \left(\frac{gp}{f}\right)^{\frac{-g}{f+g}} U_B^{\frac{1}{f+g}}.$$

Solving these for p and integrating both results over an arbitrary quantity change identifies the value functions which are used in project analysis. The following value functions are obtained for changes from an initial allocation of $(\bar{x}_A, \bar{x}_B)$ to a subsequent allocation of (x_A, x_B).

$$V_A(x_A, U_A) = U_A^{\frac{1}{d}}\left(\bar{x}_A^{\frac{-1}{d}} - x_A^{\frac{-1}{d}}\right) \text{ and}$$

$$V_B(x_B, U_B) = U_B^{\frac{1}{g}}\left(\bar{x}_B^{\frac{-f}{g}} - x_B^{\frac{-f}{g}}\right)$$

So, for example, if (U_A, U_B) specify initial utility levels, then these two value functions represent compensating surpluses. The PPO problem is to maximize the sum of the value functions subject to $x_A + x_B \leq \bar{X}$. This sum, which will be denoted $C(\underline{\bar{x}}; \underline{x}; \underline{U})$, is a distance measure. If $C(\ldots)$ is positive, then $\underline{x}$ is preferred to $\bar{x}$. By maximizing $C(\ldots)$, we find the PPO allocation of goods.

Maximizing C subject to available x results in necessary conditions for PPO in the allocation of x:

$$x_B = \left[\left(\frac{df}{g}\right)^{dg}\left(\frac{U_B^d}{U_A^g}\right) x_A^{g(d+1)}\right]^{\frac{1}{d(f+g)}} \text{ and}$$

$$x_B = \bar{X} - x_A. \qquad [5]$$

Note that this simultaneous equation solution specifies optimal x_A and x_B as functions of preference parameters and the selected utility basis (U_A and U_B). An identical procedure identifies the PPO allocation of y:

$$y_B = \left[\left(\frac{g}{df}\right)^{f}\left(\frac{U_B}{U_A^f}\right) y_A^{f(d+1)}\right]^{\frac{1}{f+g}} \text{ and}$$

$$y_B = \bar{Y} - y_A. \qquad [6]$$

The presence of U_A and U_B in equations [5] and [6] clearly indicates that different compensation tests can offer different policy recommendations.

An enlightening result obtainable from [5] and [6] is that all PO allocations are self-recommending when they are translated into a utility basis for a compensation test. That is, if (a) a PO x-y allocation is selected, (b) corresponding U_A and U_B are calculated for these bundles, and (c) these utility levels are empirically employed in [5] and [6] to calculate the PPO allocation, then the originally selected bundle will emerge as the solution to [5] and [6]. This finding can be obtained through algebraic processing of [5], [6], and the fact that the original bundle satisfies PO conditions (see the Appendix). *The consequence of this result is that every PO is a PPO for a suitably selected compensation test.*[12] The normative implications of this conclusion are obviously interesting. It is clear that the power of compensation tests to compare economic states which are Pareto noncomparable comes from the assumed utility basis. It is this assumption that gives potential Pareto criteria their power. Every different utility basis identifies a different "efficient" allocation, but economists

[12] The resemblance of this conclusion to the second theorem of welfare economics is not unexpected. Because (*a*) surplus-maximizing models simulate competitive equilibria (Samuelson 1952; Takaymama and Judge 1964) and (*b*) Pareto optima are competitive equilibria for a well-selected set of endowments (Varian 1992, 326), it is reasonable that Pareto optima are also potential Pareto optima for well-selected utility bases.

have set aside this problem by focusing attention on, especially, the Kaldor criterion.

To summarize, empirical dissatisfaction with the infinite solutions of the Pareto criterion (problem [1]) led to the creation of potential Pareto criteria (problem [2]). Each potential Pareto criterion has a unique optimum (at least for the Cobb-Douglas utility case explored here), but there are infinite such criteria, not just one or two. As a class, potential Pareto criteria offer no enhancements of the original Pareto criterion. The only refinement offered by PPO is a product of our restricted attention to Kaldor or Hicks tests and their implicit utility bases. Therefore, acceptability of a single potential Pareto criterion should be founded upon acceptance of the underlying utility basis. Furthermore, if a single criterion is to be widely employed, such as the Kaldor test is today, it should be recognized that the criterion's recommendations are conditioned by the underlying utility basis being acceptable. This is obviously a highly normative requirement.

VIII. AN EXAMPLE OF ALTERNATIVE MONETARIZATION SCHEMES

To pursue the matter of utility monetarization more tangibly, suppose that the parameters of the above scenario are given by $(d, f, g) = (2, 1, 1)$ and $(\overline{X}, \overline{Y}) = (10, 10)$. The previous results can be applied once U_A and U_B are chosen. A's and B's preferences concerning a commodity reallocation cannot be monetarized until the utility basis is selected. If we assume some initial distribution of x and y, we would know initial utilities and would be able to determine an allocation which would be optimal from the perspective of the Kaldor criterion. Similarly, we could select any utility basis lying within the region bounded by the utility possibility frontier and then employ it to compute an allocation that is optimal from the perspective of the chosen utility basis.

For the d, f, and g parameters defined above, an analytic and nonparametric form for the utility possibility frontier cannot be determined. The correct contract curve is illustrated in Figure 2 which represents the Edgeworth Box for the given conditions. As argued above, the selection of any point on the contract curve establishes a (U_A, U_B) utility basis that recommends the originally selected point as the PPO. Therefore, it is not interesting to select a Pareto economic state for setting the utility basis because we already know the outcome.

Using the nonPareto point $(x_A, y_A) = (7, 3)$ for establishing the utility basis yields $U_A = 63$ and $U_B = 21$. Substituting these utility levels into [5] and [6] to determine the PPO economic state identifies point R, $x_A = 3.773$ and $y_A = 5.183$. Note that nonPareto points such as R can be PPO for nonPareto utility bases. At point R, the obtained utility levels are $U_A = 101.3$ and $U_B = 30.0$. Application of the $\underline{U} = (63, 21)$ utility basis to compare *any pair* of points in this diagram is equivalent to finding out which point is "closer" to the optimal point R. The distance measure used to assess closeness is not Euclidean; it is the summed value functions, $C(\bar{x}, \underline{x}, \underline{U})$, used to obtain the PPO first-order conditions. The allocation that is closer to point R is "potentially Pareto preferred" to the other. For example, if we investigate a proposed reallocation from v to z in Figure 2 (that is, from $(3.6, 3)$ to $(4, 3)$) using the "R" test, we find that $C(\bar{x}, \underline{x}, \underline{U}) < 0$ implying that the reallocation is not "efficient."

Other utility bases, such as the one indicated by the dashed indifference curves ($\underline{U} = (200, 10)$), suggest other optima (in this case point S: $x_A = 5.645$ and $y_A = 7.044$) and can yield different policy recommendations when any two allocations are compared. With respect to the proposal to move from state v to state z, application of the "S" test finds that $C(\bar{x}, \underline{x}, \underline{U}) > 0$ which is contrary to the "R" test results. The "S" test recommends the move to z as efficient.

It is not novel to find that different compensation tests can yield different efficiency conclusions; this fact has long been understood from comparisons of Kaldor and Hicks criteria. However, applying either Kaldor or Hicks criteria yields the same conclusion as the "R" test in this case: $C(\bar{x}, \underline{x}, \underline{U}) < 0$, and state v is gauged more efficient. Unfor-

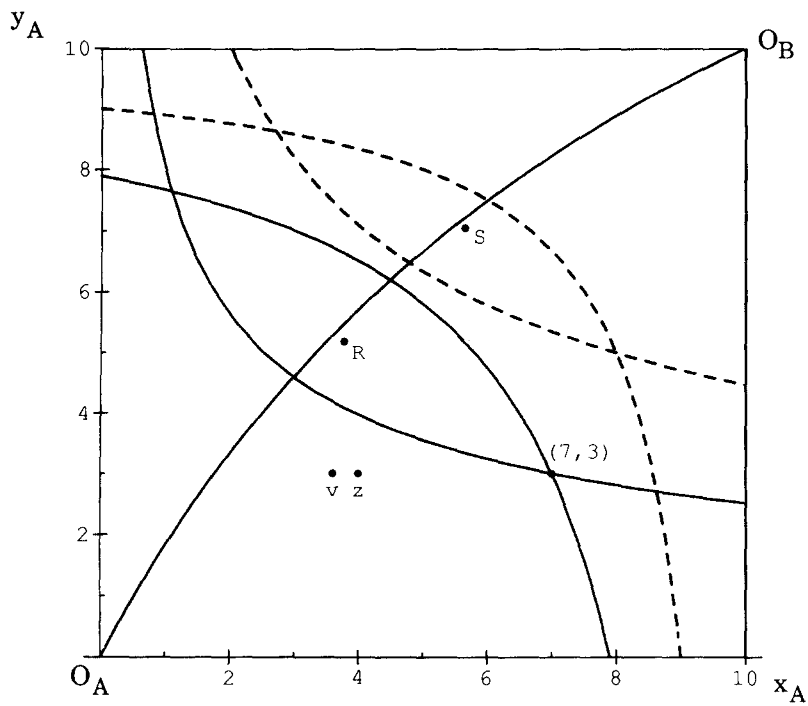

FIGURE 2
MONETARIZATION: PO VERSUS PPO IN AN EDGEWORTH BOX

tunately, the problem of selecting between *v* and *z* cannot be resolved by comparing the number of compensation tests preferring one versus the number preferring the other. Infinitely many tests will prefer *v* to *z*, and another infinitely many will prefer to *z* to *v*.

The primary point illustrated here is that there is an infinite number of potential Pareto criteria each with differing perspectives on economic efficiency. The numerical demonstration serves to focus attention on the normative underpinnings of test selection. The ability of potential Pareto criteria to resolve choices among Pareto-noncomparable economic states fully hinges upon the implicit acceptance of a single utility basis. While the Kaldor test is the utility basis employed in most applied work, it is not clear that it is the Best Utility Basis.

IX. ON CRITICISMS OF EFFICIENCY ASSESSMENTS

Having separated the alternative meanings of economic efficiency, criticisms concerning the application of efficiency criteria become plainer. Upon close inspection, one will usually find that critics are emphasizing PPO criteria when they are reproving economic efficiency as a policy measure. One example is Bromley's (1989) argument against efficiency assessments of institutional (policy) change. Bromley (1989), Samuels (1992), Schmid (1987), and other careful thinkers about the role of economics in policy analysis are concerned, in part, about the circularity of employing economic parameters such as prices or surplus measures to weigh policy pros and cons. They correctly point out that the economic parameters are, after all, consequences of the entitlements which are defined and redefined by evolving policy. Potential new entitlements cannot be neutrally gauged using data from existing entitlements.

In Bromley's parlance, "the efficient course of action... is, in general, the one that will leave the largest surplus of net benefits—regardless of how those benefits might be distributed across the polity" (1989, 2). "Changes in economic efficiency are identified by the potential Pareto improvement criterion which is the keystone of the Paretian approach" (1989, 235). "Under the traditional (or Paretian) approach there is but one objective—and that is to increase net national income; in the literature this is regarded as the 'efficiency' objective" (1989, 235). In spite of some the generalizing language Bromley employs, he is actually objecting to compensation tests, not PO, as efficiency norms. The efficiency criteria he is referring to are neither Paretian nor traditional, because PO predates PPO considerably. On the other hand, PPO criteria have supplanted PO in applied policy analysis to the extent that PPO might be regarded as the traditional manifestation of Paretian economics (Bromley 1990; Mishan 1980). Failure to distinguish between PO and PPO, however, subjects the Pareto criterion to undeservedly harsh criticism.

Similarly, Schmid (1987) focuses on the faults of the Pareto *improvement* criterion which he calls Pareto optimality. "Pareto-optimality is only relative to a given starting place and does not instruct what that initial distribution must be" (p. 213). Samuels (1992) too appears to view PO as being measured relative to an initial situation of established rights and powers. This narrow perception of economic efficiency confines us to a subset of the truly PO states of the economy. There is an important distinction between whether a state of the economy is efficient and whether a *change* to a state of the economy is efficient. The second issue pertains not to Pareto optimality but to Pareto improvement. Schmid's complaint is correct in the case of Pareto improvement, but that is not the pure Pareto criterion.

It would be a mistake to aim these authors' criticisms at the Pareto criterion which is rather innocent of the allegations. The Pareto criterion is fully capable of serving as a conceptual tool for examining the features of alternative policies and institutions. It can even be theoretically extended to account for transaction costs (Griffin 1991). The Pareto criterion can regard entitlements as completely variable and as unhindered by the status quo or any other default utility basis. Guided in this way, the economist can identify a wide range of efficient public action rather than a single, efficient action. Although it is a considerably less discriminating test of efficiency than the other tests considered here, the Pareto criterion possesses more normative appeal and substantially more immunity to criticism. "In the difficult field of welfare economics even small mercies count, so that there is much to commend in the Pareto criterion, in spite of its incompleteness" (Sen 1979, 22).

X. CONCLUSIONS

The related concepts of Pareto optimality, competitive equilibria, and potential Pareto optimality form a fundamental, disciplinary trinity in the field of economics. Pareto optimality is the pinnacle of this trinity, and it can be relied upon to cast a more complete perspective upon policy selection and upon what is and is not economically efficient. One recommendation affirmed by this investigation is that policy analysts should attempt to "rediscover" the practicality of assessing policy proposals using the Pareto norm. An important tenant of such examinations would be that there are many efficient economic states and, therefore, many efficient policies. Modern policy appraisals should attempt to explore policy options and trade-offs rather than trying to label a particular policy as "efficient" or not.

Competitive market equilibria are importantly related to Pareto optima under well-specified conditions, but markets are simply a *means* to achieve efficiency under these restricted conditions. Economists should remain mindful that markets do not define efficiency. Therefore, it is never true that a policy measure is efficient merely because "it promotes market activity."

Potential Pareto optimality is an often used definition of economic efficiency, but it is accompanied by normative flaws, and it is capable of misguiding both policy analysts and their advisees. Its additive and monetarization properties distinguish it from Pareto optimality in important respects. The additive character of this measuring rod implies that it exchanges harm for some people in return for "greater" help for others. Thus, potential Pareto rules are not innocuous tools for policy analysis. Moreover, policies deemed "efficient" by a potential Pareto criterion can even detract from individuals' *potential* welfare once the costs of corrective redistributive policy are considered. Also, while Hicks (1941) argued that repeated applications of compensation tests would tend to serve all members of society over time, interdependencies among the sequential status quo positions cast suspicion upon this claim.

The second distinguishing property of potential Pareto criteria, monetarization of welfare impacts, creates an infinite number of such criteria. Each differs in its vector-valued utility basis. This poses a serious problem because economic analysts are forced to choose among them. False language such as references to a nonexistent "Kaldor-Hicks" criterion masks the choice that must be made here and imparts a deceptive air of scientific clarity and disciplinary agreement.

It has been shown here, that *as a class*, potential Pareto criteria offer no efficiency pronouncements other than what is already provided by the Pareto criterion. The sharper edge that is provided by a *selected* compensation test arises solely from its assumed utility basis. This poses the question, "What is the Best Utility Basis?" There is not a simple answer to this question. The answer may even vary from case to case. There may be ordinary policy proposals for which the Kaldor criterion is normatively compelling. On the other hand, does it make any sense to use the Kaldor criterion to analyze policies such as agricultural income supports or rural development projects when the policy proposal is founded upon the notion that the status quo may be socially undesirable? For such policies, the Hicks criterion may be little better, because the end-state utility basis may not significantly improve the welfare of the target population.

In spite of their normative failures, it appears that potential Pareto criteria will continue to be used as indices of economic efficiency. Critics are relatively few, and the momentum of PPO users is high. Moreover, there are undoubtedly circumstances in which PPO criteria have merit. But it presently appears that use of these criteria should always be accompanied by some cautionary observations. Perhaps all policy assessments using compensation tests should possess a warning label. Given that there are alternative definitions of economic efficiency relating to policy analysis and given their differing powers, biases, and normative appeal, it seems that pronouncements regarding economic efficiency should never be uttered without first stating what standard is being employed.

APPENDIX

To show that all PO allocations for Cobb-Douglas utility functions are self-recommending when they are used to define a utility basis for a compensation test, the first equation of [5] is rewritten as

$$\frac{x_B^{d(f+g)}}{x_A^{g(d+1)}} = \left(\frac{df}{g}\right)^{dg} \frac{U_B^d}{U_A^g}.$$

Substituting in the utility levels obtained from some particular allocation $(\tilde{x}_A, \tilde{y}_A, \tilde{x}_B, \tilde{y}_B)$.

$$\frac{x_B^{d(f+g)}}{x_A^{g(d+1)}} = \left(\frac{df}{g}\right)^{dg} \frac{\tilde{x}_B^{df}\tilde{y}_B^{dg}}{\tilde{x}_A^{g}\tilde{y}_A^{dg}}$$

$$= \left(\frac{df}{g}\right)^{dg} \frac{\tilde{x}_B^{df}}{\tilde{x}_A^{g}} \left(\frac{\tilde{y}_B}{\tilde{y}_A}\right)^{dg}. \qquad [A1]$$

Assuming that $(\tilde{x}_A, \tilde{y}_A, \tilde{x}_B, \tilde{y}_B)$ is PO, $MRS_A = MRS_B$ reduces to

$$\frac{\tilde{y}_B}{\tilde{y}_A} = \frac{g\tilde{x}_B}{df\tilde{x}_A}. \qquad [A2]$$

Substituting [A2] into [A1],

$$\frac{x_B^{d(f+g)}}{x_A^{g(d+1)}} = \left(\frac{df}{g}\right)^{dg} \frac{\tilde{x}_g^{df}}{\tilde{x}_A^{g}} \left(\frac{g\tilde{x}_B}{df\tilde{x}_A}\right)^{dg} = \frac{\tilde{x}_B^{df}}{\tilde{x}_A^{g}} \frac{\tilde{x}_B^{dg}}{\tilde{x}_A^{dg}}.$$

Therefore,

$$\frac{x_B}{y_A} = \frac{\tilde{x}_B}{\tilde{x}_A}.$$

Because the ratios are equal and both allocations exhaust available $\bar{X}$, $x_B = \tilde{x}_B$ and $x_A = \tilde{x}_A$. Equations [6] and [A2] produce a similar finding for y. Therefore, the PO allocation has selected itself as the PPO allocation.

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